HEADQUARTERS

DEPARTMENT OF PORTO RICO.

Secretary of Finance

(CONTINUATION OF THE METRICAL SYSTEM)

Balances and other Weighing instruments

The only instruments that may be employed for determining weights are the following ones:

Balances of equal arms.
Balances of unequal arms.
Roman balances, or steelyards.
Assay balances.

Balances of equal arms

Balances of eqnal arms, called simply balances, or scales, should be hanging up, or else placed on a solid and sensibly level base. Their beams should be thicker than broad, particlary in the center where the knives are placed, whose cutting edges should form by their prolongation a single straight line, namely, the axis.

The points whence the scales are suspended should be at equal distances on either side of the knives.

Assay of Balances of equal arms

On proceeding to assay one of these balances, the first thing to be examined is whether its construction be a good one.

The requisites for admitting a balance as being a good one are the following:

That its make be solid and regular.

That it swing freely and with regularity.

That, on its being charged with the utmost weight that it should bear, its sensibility be at least one half of one thousandth of the said load, that is, five decigrams (half a gram) for every kilogram of its load. When the addition of this overweight to either of the scales does not cause the beam to incline toward the side where this surplus has been added, the balance is "dull" and not accurate enough. The assaying Commission should consider the use to which the balance is appropriated, whether it be delicate or gross, so as to determine the degree of sensibility which the apparatus should have in order to be accepted.

The maximum limit of the load, which should be marked on the beam, cannot be allowed to exceed one half of the weight that would be required to bend one of its arms, with the shaft as a central prop.

A balance is said to be "wild" when it tilts on the addition of a small weight without righting itself of its own accord, after the extra-weight which made it lean is removed.

The indispensable equality of both arms in commercial balances is determined by previously steadying the latter, and by placing two equal weights, one in each scale; if then the balance remains equipoised, with its needle upright, the arms are equal and the balance therefore is good in this respect.

Employment of Balances in assaying

The Assaying Commission should have at least four standard balances on hand: the first one, to test weights ranging from 20 to 5 kilograms; the second one, for weights from two kilograms to the double decagram (20 grams); the third one, which is commonly termed an *assay* or *expert's balance*, for weights smaller than 20 grams, down to the least divisions of the gram; and the fourth, which is known as the hydrostatic balance, assigned to determining the alloy of tin measures by ascertaining their specific weight.

Besides, when the importance of the service so requires it, on account of iron weights of 50 kilograms being presented to be assayed, the Commission should be furnished with a balance appropriated for such a work.

All these balances should be well chosen, sensible, and oscillating freely; those being preferable that have the longest arms, provided they should be resistent enough not to be bent by the agency of the largest weights that they are to bear in their ordinary work, and consequently, those balances whose beams or levers, resting on their axes, should have their scales suspended with most separation from each other.

It may be known that a balance swings well, when, upon a small weight being placed in it, it alternately deviates for some time from one side to the other, resting finally inclined, on its leaning to the side of the arm or of the scale, whereon the addition of the weight took place.

But if in this case the balance should lean at once toward the loaded side, remaining thus definitely inclined, without experiencing any further swinging, it shall be considered unfit for its work.

This defect, under which some balances labor, from their being thus adjusted with a view to have them extremely sensible, is corrected, either by lowering somewhat the knife on which the scales are poised, or by raising the said fulcrum, until the balance shall swing with due regularity.

Balances should never be loaded with weights surpassing those which they may safely bear, if it is desired that they should be kept in good order; and for the same reason, the Assaying Commision that should spoil a balance through any such neglect, shall incur liability.

Balances of unequal arms

No balance of unequal arms is to be employed, whose maximum load does not reach one hundred kilograms.

They should be solidy set, and oscillate freely when bearing their utmost load, upon adding thereto one thousandth more of the said charge. They should have the amount of their bearable weight expressed upon them, by their having it either engraved, or produced, in relief, on one of the lateral surfaces of their outside shaft.

These balances should be constructed in such a way that the load or charge shall constantly be either 10 or 100 times (as the case may be) as heavy as the weight which counterbalances it on the scale.

Their weights shall be of cast iron, and answer to the above-stated requisites; but, besides having their names marked on them, they should have the conventional weight which they represent marked with red ink on one of their prismatic sides, so that, for instance, the label of the kilogram shall read 10 kilograms or 100 kilograms, according to the relation that may have been established in the construction of the apparatus.

Assay of balances of unequal arms

These weighing instruments which, as a general rule are exclusively employed in wholesale trading, should all have engraved, and better still, cast, in the support whereon the bar of the balance rests, an inscription expressing the maximum charge which they may bear; and the metallic plate which they formerly used to have screwed upon them, shall be rejected, as experience has demonstrated how easy it woutd be to fix it to the upright post of any such balance, whether the latter have or have not the range therein stated.

The assaying Commission shall examine the construction of the several mechanisms or parts which constitute a balance of unequal arms, before the whole is mounted or set, bestowing considerable attention on the knives or axes of movement, which should be of cast iron, resting on tablets of the same metal; and also inspect the iron braces, which must have no defect of construction that might injure their resistance. With just as much carefulness, the Commission is to revise the remaining parts of the balance, making sure that all of them are as solid as they must indispensably be, that they may be able to resist the heavy service to which they shall be applied. After they have been put together and the balance is levelled, it will be seen whether the oscillations are quite perceptible and regular; and thereupon the degree of precision and sensibility of the apparatus are to be studied. For this purpose, a known weight of whose exactness no doubt can be entertained, shall be laid upon the platform of the balance, and on the scale prepared for the weights there shall be placed such a one as ought to counterpoise the said charge, thus testing if this charge be ten times largar than the weight, when the balance is of the sort termed "decimal", and 100 times larger when it is of the "centesimal" variety; and if in any of these cases an equipoise is established between the two weights, then one of the most necessary conditions of these apparatuses shall have been verified.

Their sensibility shall forthwith be tested; which in a good balance of these having unequal arms, should at least come up to the one thousandth of the charge with which it is tried.

Also, there is to be verified whether the dimensions are equal which are marked on the long arm; from whose extreme furthest from the fulcrum, the scale for the weights is suspended. If the said divisions, which mark kilograms, do not prove to be equal, the balance shall not be admissible. Likewise it shall be verified whether there be exactness in the divisions which sometimes are found in this arm, beyond the point where the scale for the weights hangs from; which divisions are to mark fractions of a kilogram, by means of the respective weight that should be movable along the long arm aforesaid, encircling it as though it were a ring.

The study of these balances should be preceded by that of the weights assigned to them, as indicated in Tables No. 5 and 6; which weights, besides the requisites which they should fill, as it has been stated, should bear, written on one of their sides with red ink or varnish, the value or weight which they represent when they are placed on the scale.

Roman balances

The Roman Balance is a sort of balance of unequal arms which carries its weight along with it. At the extremity of the small arm it bears either a hook or a scale or platform, ready to receive or to support the body that is to be weighed, and the long one is notched closely and at equal distances, from one of which indentations the ball or poise hangs, or on which it stops, when, by proportionately sliding it away from the small arm, or approaching it to the same, it balances the body, whose weight is marked by the notch on which the said poise duly rests.

Roman balances or steelyards should be solidly constructed; the cut or edge of the knives should be sharp enough to render the movements of the beam easy; this should be sufficiently thick to resist flexion under the weight of the poise, in such a way that the end of the beam should not graze the point of equilibrium. Their sensibility or readiness to oscillate should be equivalent to two thousandths of their charge: that is, they should oscillate upon adding to their charge two grams for every kilogram that they sustain.

All roman weights whose beams are not oscillatory remain forbidden. Also those are prohibited whose divisions do not indicate kilograms and decimal parts of the same.

Roman weights cannot be used except to determine weights larger than the kilogram.

Assay of Roman Weights

A roman weight or steelyard, in order to be good, should be endowed with the following qualifications:

When hung up, it should enjoy the utmost mobility, the sharp edge of the fulcrum allowing the beam to swing freely.

On its being loaded with any weight, it should play with ease to and fro, before it settles or poises itself.

Its arms should be strong enough not to be bent by the heaviest charge with which the steelyard may be loaded,

In case it be furnished with a needle, this should be perpendicular to the beam, and not undergo any friction with the immovable adjoining parts of the apparatus; or as in the most usual variety the extreme of the beam of the roman balance should not graze in the least the plate whereon the point of equilibrium is marked.

The divisions of the beam should all be equal.

Besides the above requisites, the appropriateness of the division of the roman balance should be ascertained. This is to be tested at least relatively to two different dividing points, preferably the first and the last. If the steelyard is assigned to weigh kilograms, and its heaviest charge is that of 20 such, it shall bear on its long arm or beam the chief divisions, marking the said kilograms with their respective numbers annexed, to wit, 1, 2, 3, and so on up to 20; and in the same manner, the space which separates each of these divisions shall contain lesser ones, that will designate the hectograms or tenths of a kilogram, arranged so that the line marking the subdivision at the center of the said space, namely, that of 5 hectograms, shall be longer than those preceding and following it, though not so long as those which mark the whole kilograms. So then, if upon being tested, the poise should not counterbalance known weights at their proper division on the beam, this shall be thus proved to be wrongly divided, and the roman balance or steelyard to which it belongs shall be rejected; unless the error be so slight that in order to reestablish the equilibrium it shall suffice to add either to the weight or to the scale or platform 1[500 of the load which has been put to be balanced, that is to say, 2 grams, for example, when the load or charge is tested with the kilogram, and 40 grams when the weight of 20 kilograms is employed.

As it may be seen, to the roman balance a larger toleration is granted than to the other balances, because, in the first place, the former, known also as steelyards, are always appropriated for large weights and for not very costly articles, and secondly, because, although roman balances have been improved in their construction, they still are deficient and susceptible of reforms that may impart to them even more sensibility.

Inasmuch as only such roman balances as swing freely are acceptable at the assay, it is convenient to keep in mind the other qualifications besides, without which they are to be rejected.

The edges of the axes or knives whereon they are poised, and the deepest part of the notches which divide the long arm or beam of the steelyard, must be in a single straight line passing very near and a little above the center of gravity of the entire lever.

The sensibility of the apparatus is increased in proportion as the center of gravity is approached by the edge of the knife or axis upon which the swinging motion takes place.